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# (54) Electrical connection through ceramic wall and method of formation thereof by brazing

(57) An electrical feedthrough comprises a ceramic element 2 having a metallized (14) aperture filled with a solidified fusible metal 12, the aperture having a capillary tube 6 central portion connecting enlarged end cavities 8, 10. A method of making the feedthrough comprise positioning a volume of fusible metal 11 above the capillary tube portion 6, in cavity 8 and melting the metal 11 so that it is drawn into the capillary 6, through to the other cavity 10.

Fig.2

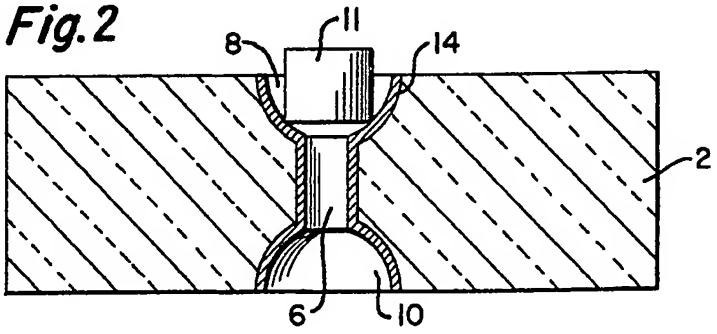
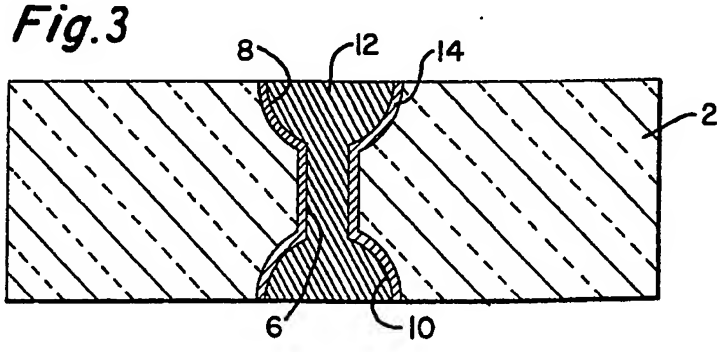



Fig.3

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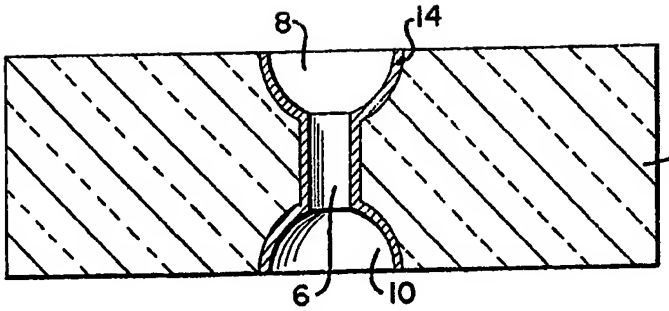


Fig. 1

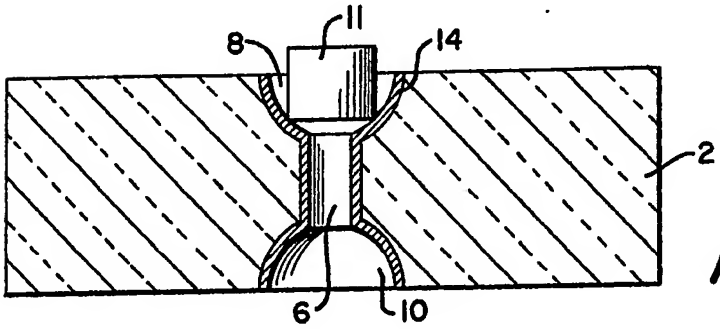


Fig. 2

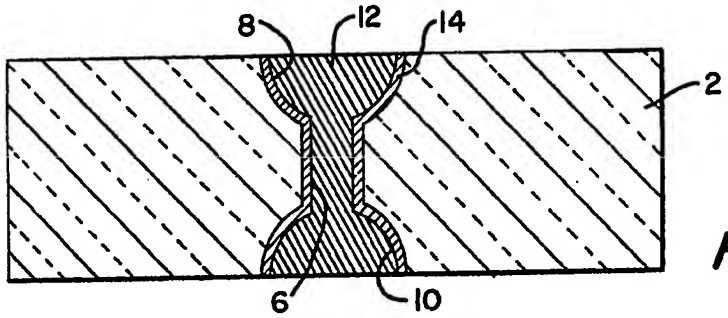


Fig. 3

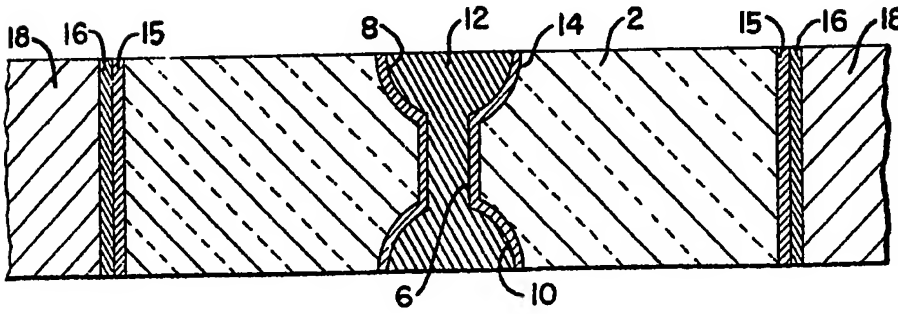


Fig. 4

SPECIFICATION

**Electrical feedthrough and method of formation thereof**

This invention relates to a hermetic metal-ceramic electric feedthrough and a method for producing it.

Ceramic brazed electrical feedthroughs are used to provide hermetic electrical connections through a ceramic wall and are frequently used to provide an insulated electrical feedthrough a metal wall, such as a battery housing. The typical feedthrough includes a ceramic member having a metallized surface, braze material preforms and an electrical feedthrough terminal pin. The metallized ceramic element is inserted into a close tolerance orifice in the metal wall, a metal terminal pin is inserted into the central hole of the ceramic piece, and braze preforms of predetermined volume are then positioned adjacent the internal and external diameters of the ceramic annulus. The temperature of the entire assembly is then raised to above the melting point of the braze material and then cooled.

It is an aim of the invention to provide an improved electrical feedthrough having improved resistance to blow-out and leakage. A further aim is to provide an electrical feedthrough wherein the conductor is formed entirely of fusible metal and is essentially dumbbell-shaped. Another aim is to provide a simple and inexpensive method of forming such an electrical feedthrough.

The feedthrough of this invention comprises a ceramic member having an aperture therethrough, the aperture having a capillary tube central portion connecting enlarged end cavities, the aperture surface being metallized, and a plug of fusible metal substantially filling the aperture and bonded to the metallized surface thereof.

Preferably, the feedthrough is made by positioning a fusible metal above and adjacent the capillary tube portion of the aperture, heating the ceramic and metal above the melting point of the metal, whereby some of the metal is drawn from the upper to the lower enlarged cavity, and then cooling to solidify the metal in the aperture.

The invention will be further described by way of example, with reference to the accompanying drawings in which:

Fig. 1 is cross-sectional view through the axis of the aperture of a metallized ceramic feedthrough member.

Fig. 2 is the same view as Fig. 1, and also showing the block of fusible metal positioned for forming the electrical feedthrough.

Fig. 3 is the same view as Fig. 1 of the completed electrical feedthrough.

Fig. 4 is a cross-section view of the feedthrough of Fig. 3 sealed in a metal wall.

With reference to the drawings, the electric feedthrough comprises a ceramic element 2, having an aperture therethrough with a metallized surface 14. The aperture includes a capillary tube central portion 6 connecting upper and lower enlarged end cavities 8 and 10. The aperture is substantially filled by a metal plug 12 bonded to the metallized surface of the aperture, which serves as an electrical conductor through the ceramic member.

The feedthrough is resistant to blowout because of the structural strength provided by the dumbbell-shape of the plug bonded to the ceramic and potential leakage paths are minimized by the small surface bond area between the capillary tube portion and the conductor.

The new feedthrough can be made by a simple and inexpensive method avoiding use of separate conductor pins or a precisely dimensioned fusible metal preform.

With reference to Fig. 1 the ceramic, typically consisting of 95% aluminum oxide and 5% glass, is metallized with a molybdenum-manganese, tungsten, or other metal to which the fusible metal will adhere. Conventionally the entire ceramic element is metallized and the metallized surface is ground away from undesired locations, for example to provide electrical insulation when the feedthrough is in a metal wall. The diameter of the capillary tube portion is sufficiently small to provide a capillary action that will overcome the surface tension of the fusible metal, suitably less than about 0.25 mm (0.01 inch) for a fusible metal such as copper.

As shown in Fig. 2, a block 11 of fusible metal having a volume substantially the same as the aperture, is positioned above the capillary portion of the aperture, at least partly in the upper cavity. The assembly is heated to temperature above the melting point of the metal block. Heating is conventionally done in a reducing atmosphere to avoid oxide contamination that may adversely affect bonding. When the block melts, metal is transferred by capillary action to the lower cavity.

The assembly is then cooled to solidify the metal resulting in the completed feedthrough, shown in Fig. 3.

The electrical feedthrough is commonly used to provide an insulated electrical feed through a metal wall, such as a battery housing. When so used, Fig. 4, the outside diameter of the ceramic element has a metallized surface 15 fitting snugly in an opening in metal wall 18. A fusible metal preform is positioned adjacent the interface, melted, and solidified to form a bond 16 between the wall and the ceramic element. The forming of the dumbbell-shaped conductor and brazing to the metal wall are done simultaneously.

It will be recognized that the feedthrough of the invention can be formed from a variety of ceramic materials, metallized surfaces, and fusible metals; the particular materials mentioned in the description are for purpose of illustration, such that all modifications and variations are included as properly fall within the scope of the accompanying claims.

CLAIMS

1. An electric feedthrough comprising a ceramic member having an aperture therethrough, said aperture having a capillary tube central

portion having a diameter less than or equal to about .25 mm (.01 inch) and connecting enlarged end cavities, the surface of said aperture being metallized, and a plug of fusible metal substantially filling the aperture and bonded to the metallized surface thereof.

2. An electric feedthrough as claimed in claim 1, wherein at least one of said end cavities is substantially hemispherical.

3. An electric feedthrough substantially as hereinbefore described with reference to Figs. 1 to 3 of the accompanying drawings.

4. A housing including an electric feedthrough as claimed in claim 1, 2 or 3.

5. A method of making an electric feedthrough comprising the steps of:

(a) forming a ceramic member having an aperture with a metallized surface, said aperture having a capillary tube central portion and upper and lower enlarged end cavities connected by the capillary tube central portion,

(b) positioning a volume of fusible metal substantially equal to the volume of the aperture above the capillary tube portion of the aperture,

(c) heating to above the melting point of the metal such that the metal is drawn by capillary action to the lower end cavity, and

(d) cooling to solidify the metal in the aperture.

6. A method as claimed in claim 5, wherein the capillary tube portion has a diameter less than or equal to about 0.25 mm (.01 inch).

7. A method of making an electric feedthrough, substantially as hereinbefore described with reference to Figs. 1 to 3 and/or 4 of the accompanying drawings.

8. The features hereinbefore disclosed or their equivalents in any novel combination.

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